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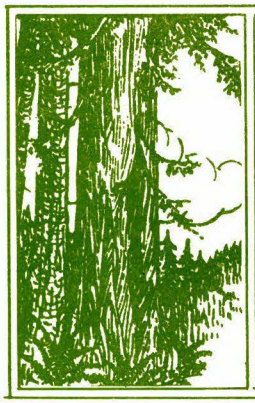
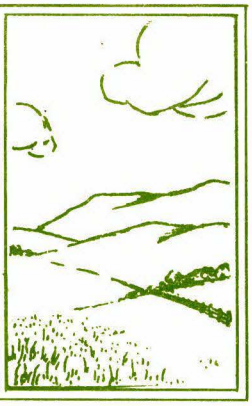


FOREST RESEARCH NOTES

U.S.DEPARTMENT OF AGRICULTURE
FOREST SERVICE
CALIFORNIA FOREST AND RANGE
EXPERIMENT STATION *

STEPHEN N. WYCKOFF, Director



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SEASONING CALIFORNIA BLACK OAK

By Harvey H. Smith

* MAINTAINED AT BERKELEY, CALIFORNIA, IN COOPERATION WITH THE UNIVERSITY OF CALIFORNIA.

Introduction

The forest industry of the Pacific Coast is based on the utilization of softwood species, and little attention has been paid to the several native hardwoods. Some of these hardwood species appear to be suitable for general commercial use. One of the most promising is California black oak (Quercus kelloggii), which grows extensively in Oregon and California, and is particularly abundant on the west slopes of the northern Sierra in canyons within the ponderosa pine belt at 3,000 to 5,000 feet elevation.

California black oak has been cut on a limited scale for manufacture into lumber and flooring. These few efforts in the past have usually met with only limited success because the operators often did not produce the quality and size of lumber to meet the needs of the prospective buyers and because it was usually poorly manufactured and seasoned. Another reason for the slow development of the hardwood industry on the Pacific Coast is the scattered occurrence of most of the hardwood species. They are decidedly scattered when compared to the softwoods growing in the same general area, but look considerably more promising when compared to many of the hardwood stands of the east from which the present supply is cut. The western hardwoods are more difficult to season[1/] than the several species of softwoods with which they are associated, and require special methods of manufacture and seasoning.

The present lack of development of the Pacific hardwoods indicates the need for more information about these species. The purpose of this study was to develop a practical, effective seasoning procedure for California black oak so that its utilization can be put on a more sound basis. These drying experiments were carried on in cooperation with the Diamond Match Company at Stirling City, California. The tests were conducted in two phases, one for air drying and another for kiln drying procedures.

Test Material

Black oak logs were cut early in June on a logging area near Butte Meadows, located in Butte County in the northern Sierra Nevada region of California. The logs represented a wide range of both size and quality. Some logs of marginal size and quality were selected to determine the yield from such material. The total log scale was about 18,000 bd. ft.; the number of large defective logs and small poorly-formed logs made an accurate scale difficult.

The logs were delivered to the mill pond and sawed without delay on a seven-foot head saw into 3/4-inch boards, which were ripped into 3- and 6-inch wide flooring strips. The strips were from 4 to 16 feet long, averaging about 8 feet. They were piled in 4-feet by 4-feet by 16-feet package units using 9 stickers per course. No narrow, dry stickers were available, and most of the stickers used were green Douglas fir and white fir, 1- by 4-inch by 4 feet in size. Some cull 3/4 by 3-inch flooring strips were cut to 4 feet in length and also used for stickers. Dry 1- by 2-inch stickers would have been preferable.

1/ Torgeson, O. W., U. S. Forest Products Laboratory Report 1684, "Kiln-drying Schedules for 1-inch Laurel, Madrone, Tanoak, and Chinquapin".

Air-drying Test Procedure

The package units were moved to the air drying yard where they were piled three high on good pile foundations. The piles were spaced 12 to 18 inches apart. Each pile was covered to protect it from the sun. The sides were protected by the adjacent piles, but the ends of the piles were open. The piling was relatively open, except for the narrow space between piles, and fast drying could be expected.

Sixteen samples[2/] were prepared and placed in the piles on the yard to determine the rate of air drying. These samples were weighed at intervals during the drying period and the moisture content determined. Weather reports were kept by the State Division of Forestry at a station only one-half mile from the yard; these reports have been used as a record of the drying conditions.

Air-drying results

The 3/4 by 3-inch and 3/4 by 6-inch strips dried rapidly (fig. 1). The average moisture content of the stock had reached 20 percent in one month. The wettest samples had dried to less than 20 percent in only 47 days, at which time all the stock could have been kiln dried readily with little danger of drying degrade.

This fast drying was accomplished with no drying defects, such as surface checking, end splitting, and honeycombing. Case-hardening stresses can not be classed as a drying defect because they develop during any normal drying process. These drying stresses can be relieved after both yard drying and kiln drying by subjecting the stock to humidity conditions that will permit a regain of moisture. Obviously, this can be done more readily in the kiln, where drying conditions can be controlled, than on the drying yard.

The small size of the flooring strips (3/4 x 3 in. and 3/4 x 6 in.) was an important factor in the fast drying without defects under the severe air drying conditions that prevailed. The results of this experiment do not permit the broad conclusion that all thicknesses of California black oak can be air dried readily without drying defects, but the results do show that 3/4-inch strips can be air dried successfully when piled properly on the yard. Furthermore, this experience with 3/4-inch stock indicates that full one-inch stock can be air dried successfully.

These results show a drying rate that can be duplicated only during the active drying season. Similar material handled in the same way, but piled during the wet, cold fall and winter season, would require considerably longer to dry. The danger from surface checking would also be much less during this slow drying season, which may be important in air drying thicker stock without defects.

2/ U. S. Forest Products Laboratory Report 1607, "Use of Kiln Samples in Operating a Lumber Dry Kiln".

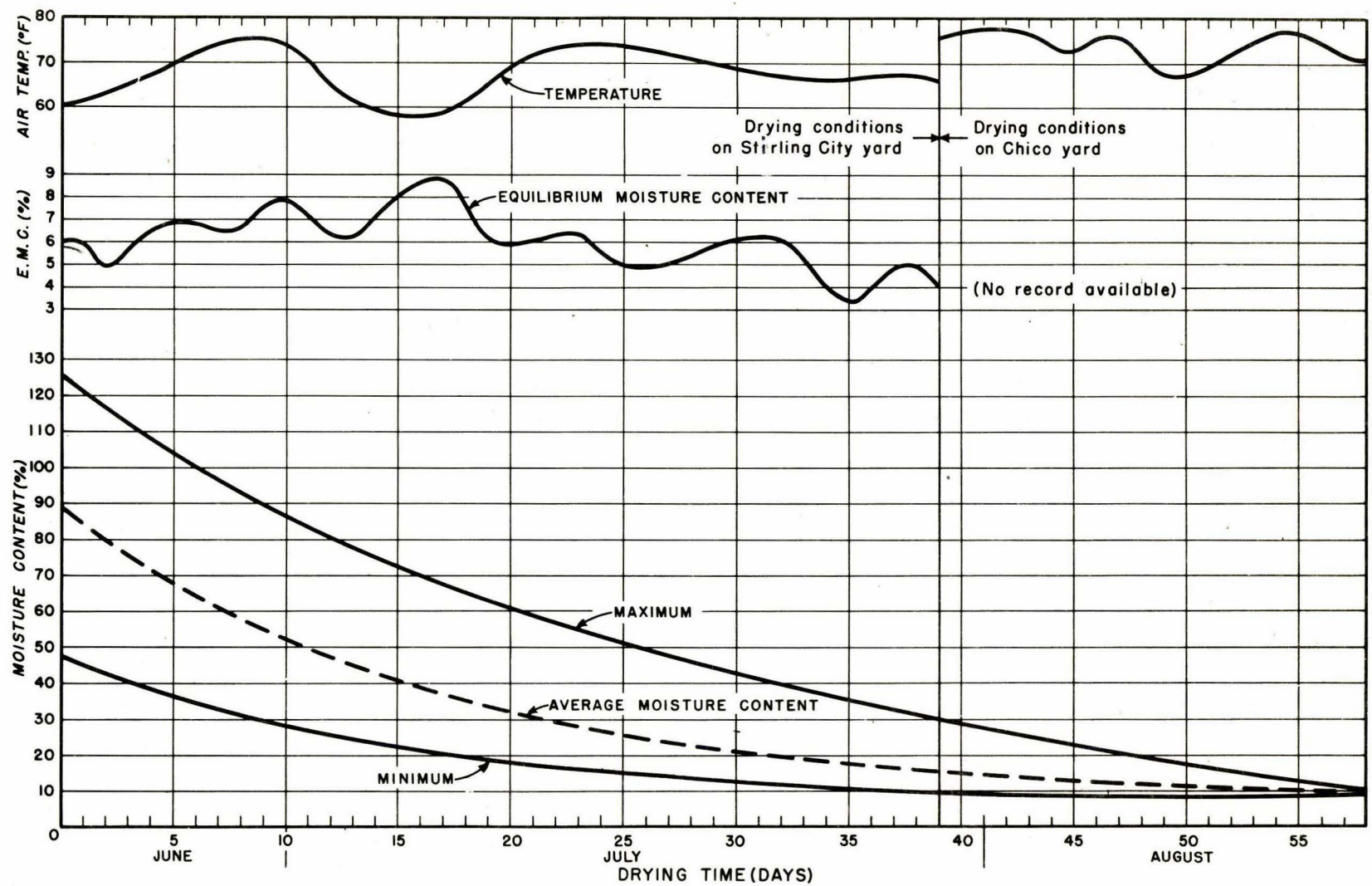

Figure 1.--Air drying conditions on the yard and the resultant drying rate of 3/4 by 3-inch and 3/4 by 6-inch California black oak flooring strips.

Kiln-drying Test Procedure

Four kiln runs were made in a small experimental dry kiln[3] and one in a large commercial kiln. Each charge in the small kiln contained 400 to 500 bd. ft. of 3/4-inch strips. Each load was 4 feet wide, 8 feet long and 4-1/2 to 5 feet high. At the time of the first experimental kiln run, this stock had been on the air drying yard four weeks and had dried to a moisture content of 26 percent. By the time of the fourth run it had further dried to 18 percent and at the time of drying in the commercial kiln had reached a moisture content of only 10 percent.

The drying conditions used in the first run in the experimental kiln were somewhat conservative (fig. 2). Because the results were encouraging, the dry bulb temperature during the next run was maintained at 180° F. This temperature is more severe than usually used. In run No. 4 (fig. 3) the initial dry bulb temperature of 140° F. was held until the average moisture content of the samples was 15 percent, then the temperature was raised to 180° F.

The relative humidity conditions during these experimental runs were controlled to maintain a rather low equilibrium moisture content[4]. The stock had already dried considerably during air drying and a moisture gradient was already established. The surface fibers were no longer in tension across the grain and there was no further danger from checking. Therefore the relative humidity in the kiln was lowered to 20 to 30 percent after only a few hours at 50 to 60 percent. These low relative humidity conditions were conducive to rapid drying and could be used safely since the danger from checking had passed.

The strips had air dried to such a low moisture content before being dried in the commercial kiln that there was no real kiln drying problem. The dry bulb temperature was held at 140° F. with a wet bulb depression of 40° over one night. The dry bulb temperature was then raised to 180° F., while maintaining a 40° F. wet bulb depression (wet bulb temperatures raised from 100° F. to 140° F.). After 24 hours of drying the stock was equalized for 16 hours at an 8.0 percent equilibrium moisture content (160° F. dry bulb and 140° F. wet bulb). The stock was conditioned for two hours at 160° F. dry bulb temperature and 152° F. wet bulb temperature to relieve drying stresses. The total time in the kiln was only 42 hours and could have been reduced by several hours had it been necessary to do so.

Kiln-drying Results

The results obtained from the four runs in the small experimental kiln and one run in the commercial kiln indicate that air dried California black oak can be kiln dried as readily as eastern red oak.

3/ Torgeson, O. W., U. S. Forest Products Laboratory, Report 1671, "Small Demountable-type Lumber Dry Kiln for Experimental Drying".

4/ Smith, H. H., U. S. Forest Products Laboratory Report 1651, "Relative Humidity and Equilibrium Moisture Content Graphs and Tables for Use in Kiln Drying Lumber".

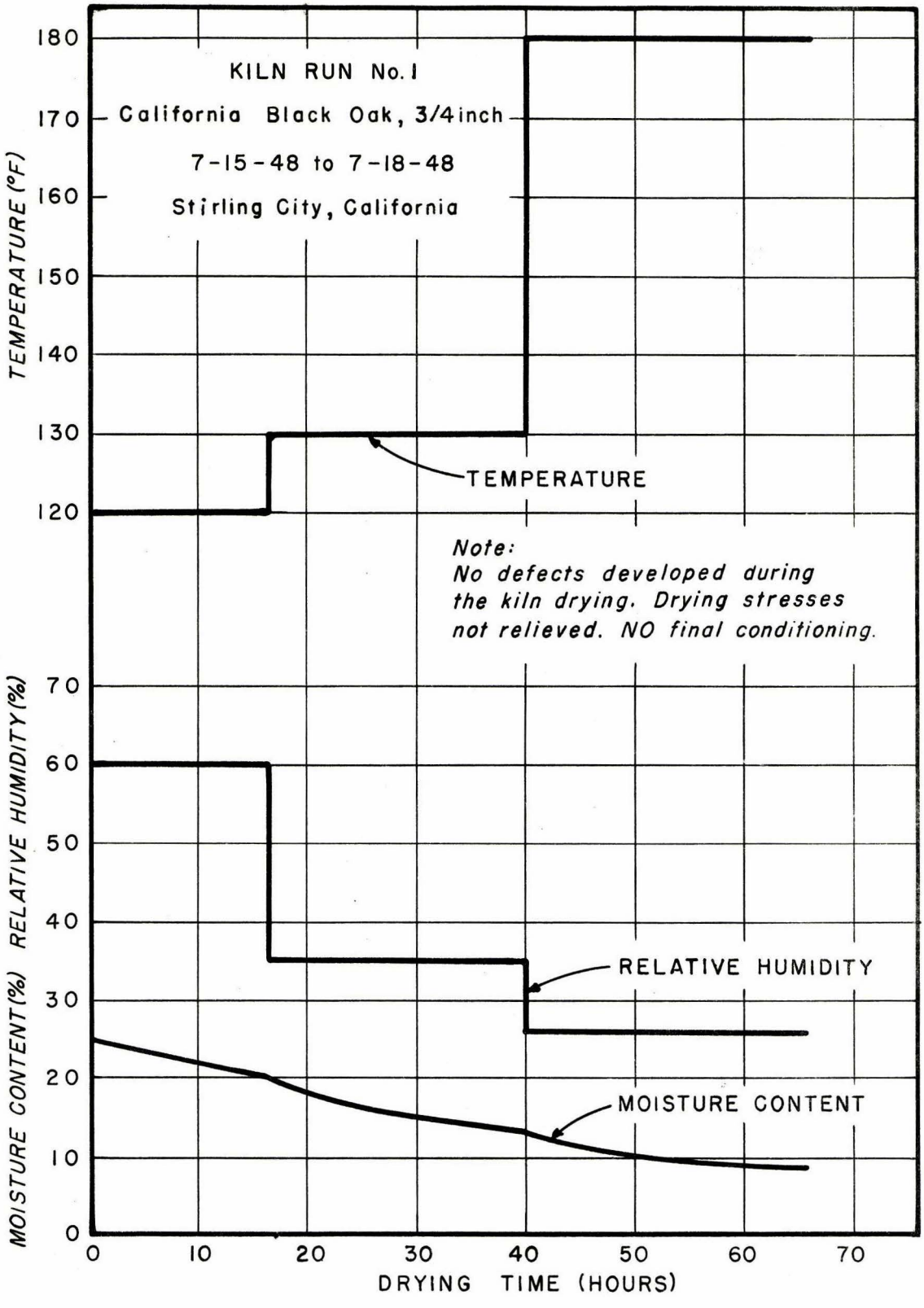

Figure 2. - Test run of 3/4-inch California black oak flooring strips in experimental kiln using moderate drying schedule.

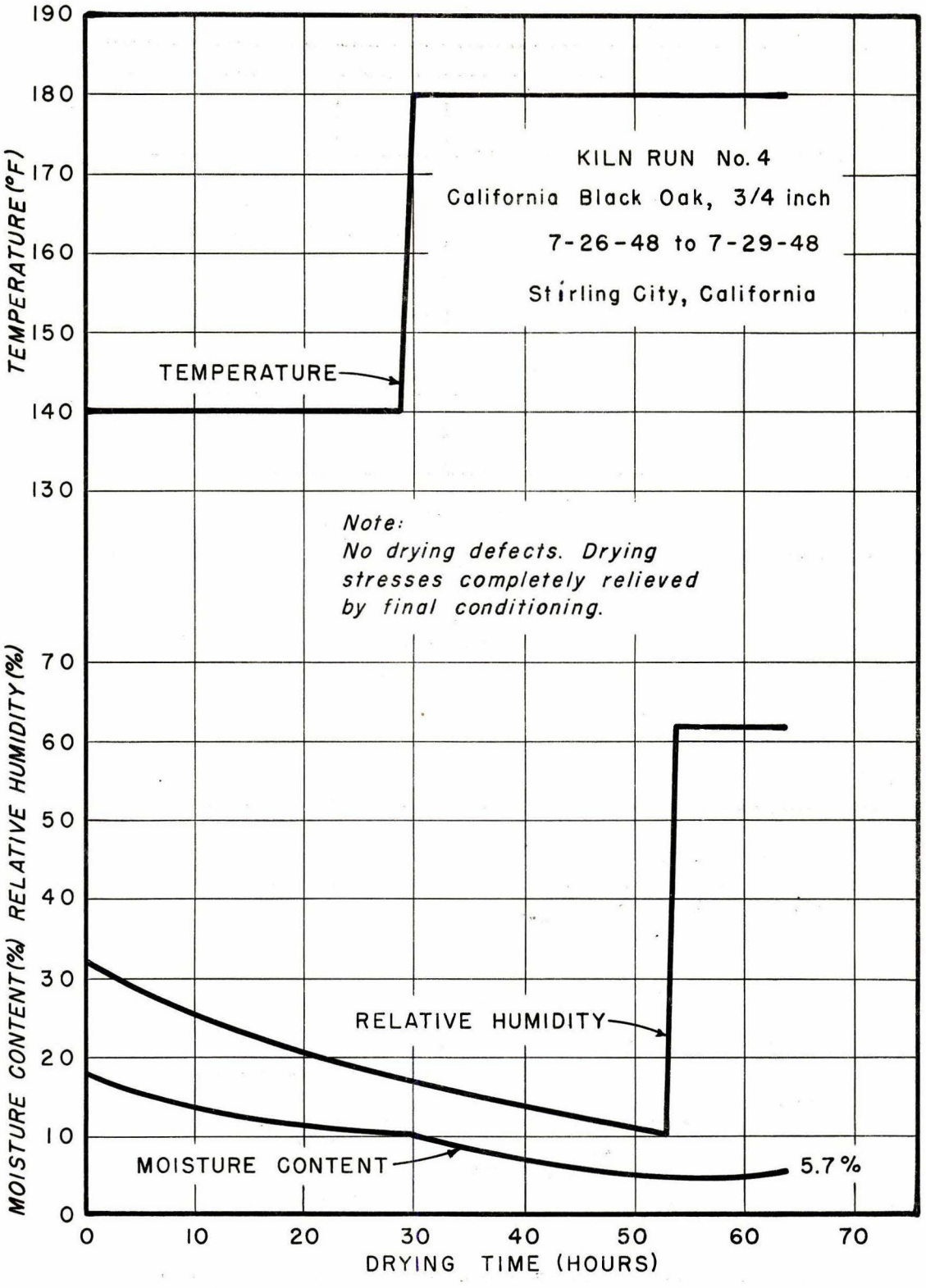

Figure 3.- Test run of 3/4-inch California black oak flooring strips in experimental kiln using accelerated drying schedule with final conditioning.

Figures 2 and 3 show the drying conditions in two of the experimental runs. The drying time was 66 and 64 hours, respectively. The drying conditions in the second were more severe and the total drying time of 64 hours includes a 10-hour conditioning treatment to relieve the drying stresses.

Drying defects occurred in only the second experimental kiln run, in which the initial temperature was 180° F. In this run severe honeycomb developed in some areas of the stock that had been covered by the wide, green stickers used during air drying. Wood in these areas had been covered during air drying and had not been subject to the same drying conditions as the wood between the stickers. It had not dried to a sufficiently low moisture content to withstand the high kiln temperatures without serious defects.

The development of honeycomb in wet areas of this oak, but not in adjacent drier areas, substantiates the theory that wood that has been dried below the fiber saturation point[5], and thus contains no free water, can be kiln dried at high temperatures without danger from drying defects.

Conclusions

The results of these experiments indicate that California black oak, cut into thin sizes, can be dried in a relatively short time without drying defects.

Three-quarter inch stock can be air dried in only 6 weeks during the active drying season, but may require at least twice that long a time during the wet, winter weather. The method of piling will affect the rate of drying and the extent of warping during air drying. If it is found that 4/4 or thicker stock checks when piled for air drying by the method used in this experiment, modifications of the piling can be made to slow the rate of drying and thus reduce the occurrence of drying defects[6].

The kiln drying of previously air dried 3/4-inch stock is relatively easy and can be accomplished in a modern forced-circulation fan kiln in less than 3 days without drying defects. A schedule using 140° F. dry bulb temperature until the moisture content reaches 15 percent and then a final temperature of 180° F. can be recommended. The initial relative humidity should be about 50 percent, but can be lowered to the desired minimum by the end of the second day.

5/ Stamm, A. J., U. S. Forest Products Laboratory Report 859, "The Fiber-saturation Point of Wood as Obtained from Electrical Conductivity Measurements".

6/ Espenas, L. D., U. S. Forest Products Laboratory Report 1657, "Air Seasoning of Lumber".

The following kiln schedule is suggested for air dried 3/4 flooring strips up to 6 inches in width:

Moisture Content at which change is to be made, percent	Dry Bulb	Wet Bulb	Relative Humidity	Equilibrium Moisture Content
	°F.	°F.	pct.	pct.
25	140	120	54	8.0
20	140	100	25	4.1
15 to Final	180	130	26	3.3
Equalizing (8 to 12 hrs. for final MC of 6% to 8%)	180	150	47	5.7
Conditioning (2 to 4 hrs. for final MC of 6% to 8%)	180	168	75	10.1